DOCUMENT RESUME

ED 233 680 IR 010 770

AUTHOR	Patrick, J.
TITLE	Computer Based Training - A Report of a NATO Study Visit to America. A.P. Report 91.
INSTITUTION	Aston Univ., Birmingham (England).
SPONS AGENCY	North Atlantic Treaty Organization, Brussels (Belgium). Scientific Affairs Div.
PUB DATE	Jan 80
NOTE	29p.; Prepared in the Department of Applied Psychology.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Computer Assisted Instruction; *Computer Managed Instruction; Flight Training; Foreign Countries; *Industrial Training; Instructional Development; *Job Training; *Military Training; Program Descriptions; Remedial Instruction; *Research Projects
IDENTIFIERS	Canada; Fault Diagnosis; PLATO; United States

ABSTRACT

This report describes some of the research projects encountered on a 1979 study visit which investigated the nature and availability of computer-based training (CBT) systems in the United States and Canada, particularly within industrial, occupational and military contexts. An overview of the trip itinerary includes the names of the organizations visited, their addresses and telephone numbers, the names of research workers encountered, and the dates of the visits. References to published information on each project are also provided. Projects described include those of: the National Research Council of Canada; Bolt, Beranek & Newman; Dr. R. B. Miller; HUMRRO (the Human Resources Research Organization); the Army Research Institute; the Naval Training Equipment Center; the Training Analysis and Evaluation Group (TAEG) of the Department of the Navy; the University of Illinois's Computer Based Education Laboratory, Coordinated Science Laboratory, Aviation Institute, and Psychology Department; the Naval Personnel Research and Development Center (NPRDC); and the Behavioral Technology Laboratory of the University of Southern California. A final section presents some general conclusions concerning computer-based training. (ESR)

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A.P. Report 91

COMPUTER BASED TRAINING - A REPORT OF A NATO STUDY VISIT TO AMERICA

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ACKNOWLEDGEMENTS

The author is indebted to the Scientific Division of NATO for providing a study visit grant which made this research possible. The author would also like to thank the many individuals in each of the research organisations detailed in this report who generously gave their time and energy to explain and discuss research issues.

2. PREFACE

The purpose of the study visit to America was to investigate the nature and availability of computer based training systems, particularly within the industrial, occupational and military contexts. The purpose of this report is to describe the nature of some of the research projects encountered. This, together with names, addresses and references should be useful to other research workers in this field and the author would be pleased to elaborate any of this information on request.

It should be noted that the organisations visited were selected on the basis of the author's knowledge of this research area and were not therefore necessarily representative or exhaustive. Inevitably during such a visit, the author became aware of research projects in other organisations which could not be encompassed due to lack of time. Also during nearly every visit one became aware of interesting projects in the area of training although not directly in computer based training. These have been included in this report. It is also fair to state that some projects encountered at the organisations visited are not included in this document and the reader should therefore realise that the projects described are again not necessarily exhaustive or representative of the research efforts of any one organisation.

Section 3 of this report is an overview of the itinerary of this study visit. This includes the name of the organisation, address, telephone number, research workers encountered and date visited. In Section 4 of this report is a brief description of some of the more interesting projects encountered at each organisation together with any references which were accumulated. Section 5 is an attempt to make some general conclusions concerning computer based training as a consequence of the projects encountered.

3. OVERVIEW OF ITINERARY

3.1 National Research Council

Address: Information Science Section
Electrical Engineering Division
National Research Council of Canada
Ottawa K1A
CANADA

Telex: 053-4134

Telephone: 613-9932484

Hosts: Dr. J.W. Brahan (Director) and
Mr. Bob McNarry

Date: 10th-11th July 1979

Associated Visits:
Bob Knights
Dept. of Psychology
Carleton University

Ted Davies/Al Anderson
Agonif Community College

3.2 Bolt Beranek & Newman Inc.

Address: 50 Moulton Street
Cambridge
Massachussets 02138
UNITED STATES OF AMERICA

Telex: 92-1470

Telephone: 617-491-1850

Hosts: Drs. Allan Collins, Al Stevens,
Dick Rubenstein and Wally Feurzeig

Date: 12th July 1979

3.3 Dr. R.B. Miller

Address: Colonial House
South Road
Poughkeepsie
N.Y. 1260
UNITED STATES OF AMERICA

Date: 13th July 1979

3.4 HUMRRO

Address: Human Resources Research Organisation
300 N. Washington Street
Alexandria
Virginia 32314
UNITED STATES OF AMERICA

Telephone: 703-5493611

Hosts: Dr. Saul Lavisky
Dr. Robert Seidel

Date: 16th July 1979

3.5 Army Research Institute

Address: Department of the Army
US Army Research Institute for the
Behavioural and Social Sciences
5001 Eisenhower Avenue
Alexandria
Virginia 22333
UNITED STATES OF AMERICA

Telephone: 202-2748 (913 or 943)

Hosts: Dr. Joseph Zeidner (Director)
Dr. Jim Baker, Dr. Harry O'Neil
plus others.

Date: 17th July 1979

3.6 Naval Training Equipment Center

Address: Department of the Navy
Naval Training Equipment Center
Orlando
Florida 32813
UNITED STATES OF AMERICA

Hosts: Mr. J. Marro, Dr. Walter Chambers,
Dr. Stan Collyer, Dr. P. Van Hemel,
Dr. R. Breaux

Date: 19th July 1979

3.7 Task Analysis and Evaluation Group

Address: TAEG
Department of the Navy
Orlando
Florida 32813
UNITED STATES OF AMERICA

Hosts: Dr. A. Smode, Dr. Kinkade
plus others

Date: 20th July 1979

3.8 Computer Based Education - University of Illinois

Address: Computer-based Education Research Laboratory
University of Illinois at Urbana-Champaign
Urbana
Illinois 61801
UNITED STATES OF AMERICA

Telephone: 217-333-6210

Host: Mr. Bill Golden, Stan Smith

Date: 23rd July 1979

3.9 Coordinated Science Laboratory - University of Illinois

Address: Coordinated Science Laboratory
Department of Mechanical and Industrial Engineering
University of Illinois
Urbana
Illinois 61801
UNITED STATES OF AMERICA

Host: Bill Johnson

Date: 24th July 1979

3.10 Aviation Institute, University of Illinois

Address: Aviation Research Laboratory
Institute of Aviation
University of Illinois: Willard Airport
Savoy
Illinois 61874
UNITED STATES OF AMERICA

Telephone: 217-333-3162

Hosts: Dr. Doug Dennis, Dept. of Secondary Education; Sally Standiford

Date: 24th July 1979

3.11 Psychology Department, University of Illinois

Address: Dept. of Psychology
University of Illinois
Champaign
Illinois 61820
UNITED STATES OF AMERICA

Hosts: Dr. Stan Roscoe, Dr. W. Schneider
Dr. J. Adams

Date: 25th July 1979

3.12 Naval Personnel Research and Development Center

Address: NPRDC
San Diego
California 92152
UNITED STATES OF AMERICA

Telephone: 714-225-672[illegible] ext. 7106

Hosts: Dr. J. Regan, Dr. Bill Montague
Mike Williams, Tom Duffy, Dr. Aitken,
Burl Ellis, Wally Wolfeck,
Nick Van Moder

Date: 26th July 1979

3.13 Behavioural Technology Laboratories

Address: 3716 South Hope Street
University of S. California
University Park
Los Angeles
California 90007
UNITED STATES OF AMERICA

Telephone: 213-741-2127 ext. 2311

Host: Dr. D. Towne

Date: 27th July 1979

4. DESCRIPTION OF PROJECTS

4.1 National Research Council

General: NRC completed a national authoring language (NATAL) in 1974. A lot of research has subsequently been devoted to teaching and testing in areas of remedial education and training.

BRAHAN, J.W. (1976) Computer Aided Learning - A Cooperative Research Project of NRC. AMTEC Conference Paper, Newfoundland.

BRAHAN, J.W. & WESTRON, M.L. (1978) NATAL-74-First Results. Proceeding of the ADCIS Conference - New Directions in Educational Computing.

BRAHAN, J.W., COLPITTS, B.A., GOGUEN, J.R., HLADY, A.M. & ORCHARD, R.A. (1976) NATAL-74. Definition and Development of a Course Authoring language to meet National Requirements. Proceedings of 2nd Canadian Symposium on Instructional Technology, Quebec.

KNIGHTS, R.M., RICHARDSON, D.H. & McNARRY, L.R. (1973) Automated vs Clinical Administration of the Peabody Picture Vocabulary Test and the Coloured Progressive Matrices. American Journal of Mental Deficiency, 78, 2, 223-225.

Projects. (a) CARE. This is a Computer Aided Remedial Educational programme designed to train teachers to recognise and deal with problems of handicapped children. This has been implemented although the programme is at present not totally finished.

(b) Cerebral palsied children. A microprocessor can interact with such verbally impaired children by displaying Bliss symbols on a monitor from which the user selects a message. This can be transmitted to other terminals within a classroom. Also the use of voice synthesisors in such situations is being examined.

GIDDINGS, W., NORTON, J., NELSON, P., McNAUGHTON, S. & REICH, P. (1979) Development of a Blissymbol Terminal: An interactive TV Display to enhance communications for the physically handicapped. Proceedings of 6th Man-Computer Conference, Ottawa, Canada.

NELSON, P.J., COSSALTER, J.G., CHARBONNEAU, J.R., & ORPANA, F.P. (1977) Speech Synthesis for Non-Verbal Children - A Progress Report. Proceedings of the 4th Annual Conference on Systems and Devices for the Disabled. Seattle.

(c) Diagnostic and remedial tutoring using CAL for children

with reading, spelling and arithmetic deficiencies (Dr. Knights, Carleton University).

KNIGHTS, R.M. & HARDY, M. (1976) A child-computer-teacher assessment and remedial program for children with poor reading skills. Research Bulletin no. 14, Dept. of Psychology.

(d) An impressive set of programmes for teaching understanding or comprehension of text material. This is implemented in an English course at Agonif College by Ted Davies. The programmes are sophisticated in their assessment of the student's understanding and the variety of levels of remedial support available.

* For full review of research activities of Division of Electrical Engineering, NRC, see Bulletins 1978, 1979, Vol 1, Nos. 4 & 5.

Projects: (a) Steam simulation plant. Computer controlled with colour graphics and designed to teach procedures involved in starting and controlling such a system (Dr. A. Stevens).

(b) SOPHIE is a sophisticated instructional computer based electronic troubleshooting environment. The laboratory simulates the equipment in order to answer a student's questions, provide measurements at various points in the circuit etc. and also to provide information concerning possible changes in the circuit. This laboratory has been extended to include a team troubleshooting game and an expert debugger/explainer (Dick Rubenstein).

BROWN, J.S., RUBENSTEIN, R. & BURTON, R. (1976) Reactive learning environment for computer assisted electronics instruction. BBN Report, no. 3314, ICAI Report No. 1.

BURTON, R.R. & BROWN, J.S. (1978) Intelligent CAI: An Author Aid for a natural language interface. BBN Report no. 3913, ICAI Report No. 11.

(c) ORLY programme which is a part-task flight simulation system. At present concerned with the development of computer based analysis methods which can provide qualitative feedback during flight instruction. In the future possible use of predictive displays are being considered. (Wally Fuerzeig).

FEURZEIG, W., LUKAS, G., STEFANESCU, D. & BEDINGER, P. (1979) Higher order adaptive training. Technical Report NAUTRAEQUIPCEN 77-C-0123-4.

LUKAS, G., FEURZEIG, W. & COHEN, D. (1977) ORLY - A Mini computer-based instrument flight training simulator. Aviation Research Journal, II, 55-64.

(d) The structure of knowledge. Application of interactive programmes such as 'Buggy' to help teachers in diagnosing student weaknesses and providing remedial support. The problem of learning is conceptualised as debugging the students inappropriate conceptual model.

COLLINS, A. (1978) Explicating the tacit knowledge in teaching and learning. BBN Report no. 3889.

STEVENS, A. & COLLINS, A. (1978) Multiple Conceptual Models of a complex system. BBN Report no. 3923.

STEVENS, A., COLLINS, A. & GOLDIN, S.E. (1979) Misconceptions in students understanding: International Journal of Man-Machine Studies, 11, 145-156.

STEVENS, A. & COLLINS, A. (1977) The goal structure of a Socratic Tutor. In Proceedings of the Association for Computing Machinery National Conference, Seattle, Washington.

COLLINS, A. (1976) Processes in acquiring knowledge. In Schooling and the acquisition of knowledge. Hillsdale N.J. Lawrence Erlbaum Associates.

See Cognitive Science Journal - ABLEX publishing corporation, Narwood, New Jersey.

BROWN, J.S. & BURTON, R.R. (1978) Diagnostic models for procedural bugs in basic mathematical skills. Cognitive Sciences, 2, 155-192.

General References

BROWN, J.S., BURTON, R., MILLER, M., DEKLEER, J., PURCELL, S., HAUSMANN, C. & BOBROW, R. (1975) Steps toward a theoretical foundation for complex, knowledge based CAI. BBN Report no. 3135, ICAI Report no. 2.

BROWN, J.S., COLLINS, A. & HARRIS, G. (1978) Artificial Intelligence and Learning Strategies. In Learning Strategies. Academic Press.

BURTON, R.R. & BROWN, J.S. (1978) An investigation of computer coaching for informal learning activities. BBN Report no. 3914, ICAI Report no. 12.

FISCHER, G., BROWN, J.S. & BURTON, R.R. (1978) Aspects of a theory of simplification, debugging and coaching. BBN Report. no. 3912, ICAI Report no. 10.

4.3 Dr. R.B. Miller

The discussion covered the implications of various task formats for training, problems in training of cognitive tasks and the problem of transfer of training at the job level. These areas were related to the potential usage of computer based training methods.

Reference

MILLER, R.B. (1971) A Taxonomic Base for Future Management Information and Decision Systems. Theoretical Background to the Design of Duty Modules. Technical Research Note ARPA Order No. 1623.

4.4 HUMRRO

Projects: (a) Post Office Sorting Task.

This involves a project conducted for the US Postal Service in which a computer based system was developed for training Multi-Position Letter Sorting Machine operators. The project uses the CHARGE graphics terminal to simulate a variety of computer generated envelopes, designs, handwriting, etc. The trainees have to learn to identify different postal codes and they progress through a variety of modules in a self paced series of instructional programmes. There are various criteria speeds for the different modules (e.g. 60 letters/min. for the first few modules). Students can review previous modules or the instructors can override the programme sequence and send trainees into a self study module. This computer based training has been implemented in New York City although not finally evaluated.

HILLELSOHN, M.J., ROSENBLATT, R.D., PRICE, P. & SEIDEL, R.J. (1976) Task Analysis of Multiple Position Letter Sorting Machine Operator's Job. RP-ED-76-18

(b) Instructional Features of CAL.

Some research has investigated the importance of learner control in an adaptive tutorial CAL environment whilst another project has considered the effect of the computer/system's response time.

SEIDER, R.J., WAGNER, H., ROSENBLATT, R.D., HILLELSOHN, M.J. & STELZER, J. (1978) Learner Control of Instructional Sequencing Within an adaptive tutorial CAI Environment. Instructional Science, 7, 37-80.

(c) Evaluation.

A technique called Transactional Evaluation has been utilised to assess attitudes and potential problems identified with a new research or instructional programme. This may be particularly useful when considering the implementation of any form of computer based training when attitudes and changing roles may be more important determinants of a successful implementation that the instructional or technical features per se.

WAGNER, H. & SEIDEL, R.J. (1978) Program Evaluation. HUMRRO Professional Paper 11-78.

SEIDEL, R.J. (1978) Transactional Evaluation: Assessing Human Interactions During Program Development. HUMRRO Professional Paper 8-78.

General References

SEIDEL, R.J. (1977) Technology Forecast: Participant Profile. In Computers and Communications, Implications for Education. Academic Press.

Bibliographies of HUMRRO publications 1971-88

HARGAN, C. & HUNTER, B. (1978) Instructional Computing - Ten case studies. HUMRRO

Academic Computing Directory. A Search for Exemplary Institutions Using Computers for Learning and Teaching. HUMRRO 1977.

4.5 Army Research Institute

Projects (a) ACTS

This is an Adaptive Computerised Training System which is designed to train electronic troubleshooting. ACTS simulates the electronic circuit, develops both student and expert troubleshooting models and provides feed-back during training. This remains to be fully evaluated.

KNERR, B.W. & NAWROCKI, L.H. (1978) Development and Evaluation of An Adaptive Computerised Training System. ARI R & D Utilisation Report 78-1. ADA065839

(b) Interactive Computer Displays

Consideration of their effectiveness for computer aided instruction.

MOORE, M.V. & NAWROCKI, L.H. (1978) The Educational Effectiveness for Graphic Displays for Computer Assisted Instruction. ARI Technical Paper 332.

(c) Basic Skills Training

The Plato system has been used by the Army in the area of language, arts and mathematics.

SIEGEL, M.A. & SIMUTIS Z.M. (1959) CAI for Adult Basic Skills Training:Two Applications. Paper presented at the Association for the Development of Computer-Based Instructional Systems.

(d) A great deal of research effort is directed at the development of concepts and criteria for training systems, including task analysis. One needs to be able to predict from task analysis how much can be trained on existing equipment, the transfer of training function and its cost. Also when can imbedded training (using the piggy-back principle) be efficiently used on operational computerised equipment? This will be more important with the tendency to decentralise away from the training school.

General References

List of Research Publications up to and including 1977.

BAKER, J.D. (1977) How will improvements in man-machine interface effect learning? In computers and Communications, Implications for Education, Academic Press.

O'NEIL (1977) Ed. Proceedings for Instructional Systems Development. Academic Press

BAKER J.D. (1969) The training effectiveness of simulation. Paper to Society for Applied Learning and Technology.

BAKER J.D. (1968) Computers, collective training and validity. Discussion paper conference above.

4.6 Naval Training Equipment Center

Projects (a) AWAVS. This is an Aviation Wide Angle Visual System which is a flight simulator system in which images of, for example, landing on an aircraft carrier can be generated from a computer or a terrain model. The purpose of the system is to determine those criteria which need to be included in the design of future flight simulator visual systems. For example, what is the effect of various fields of view and availability of motion simulation on both learning and transfer? What are the optimal means of presenting feedback information on, for example, sink rate and which are the most efficient instructional strategies? (For example, the system has the ability to freeze the simulated display). This work utilises Simon's methodology to attempt to isolate those simulator variables which are likely to be most influential.

COLLYER, S.C. & CHAMBERS, W.S. (1979) AWAVS, A Research Facility for Defining Flight Trainer Visual System Requirements.

SIMON, C.W. (1979) Applications of Advanced Experimental Methodologies to AWAVS Training Research. Tech. Rep. NAVTRAEQUIPCEN 77-C-0065-1.

Gavan Lintern is now working on this project and some of his previous work is relevant to this area:

LINTERN, G. (1978) Transfer of Landing Skill after Training with Supplementary Visual Cues. Prepared for Air Force System Command. Tech. Rep. Eng. Psy. 78-3/AFOSR-78-2.

(b) Maintenance Training. An A-7 HUD Test Bench Simulator which is a realistic mock up of the equipment. Technicians make tests and checks with a computer monitored system. Various realistic circuit boards can be probed with test equipment with computer generated answers. This system is at present in a development phase (Dr. W. King & Dr. P. Van Hemel).

(c) GCA. Ground Control Approach simulation which trains air traffic controllers via a simulated flight path on a VDU and computer generated simulations of pilot speech. The system also accepts voice input. This system has been documented in the literature (Dr. R. Breaux).

4.7 Training Analysis and Evaluation Group

Projects (a) Flight Simulation. The usefulness of various flight simulators for reducing aircraft training time and effecting positive transfer of training.

SMODE, A.F. (1979) Flight Hour Reductions in Fleet Replacement Pilot Training Through Simulation. TAEG Professional Paper TN-5-79.

(b) Electronic warfare training. This is a programme of research initiated in 1972 which includes task analysis, curriculum design and development and the use of various training technologies.

PEARSON, T.E., MACKERAGHAN, L.R. & STUBBS, W.B. (1978) Training Analysis and Evaluation Group. TAEG Rep. no. 56.

(c) Preparation of instructional materials with computer help. A large research effort is directed at facilitating the speed and clarity of publications of instructional material in the Navy. One computer aided authoring system provides the instructor with feedback concerning the readibility of text material which has been prepared (in terms of, for example, frequency of words, length of sentence, etc.). A second computer programme automatically produces text material for teaching symbol recognition. Often new sets of symbols have to be learned and the package includes a pretest, tutorial exercises, criterion tests and suggestions for refresher training.

KEELER, F.L. (1977) An Automated Publishing System for the Naval Education and Training Command. TAEG Rep. no. 50.

BRABY, R., PARRISH, W.F., GUITARD, C.R. & AAGARG, J.A. (1978) Computer Aided Authoring of Programmed Instruction for Teaching Symbol Recognition. TAEG Rep. no. 58.

BRABY, R. & KINCAID, J.P. (1978) Use of Mnemonics in Training Materials: A Guide for Technical Writers. TAEG Rep. no. 60.

4.8 Computer Based Education Laboratory - University of Illinois

General: The PLATO system is well documented and is used at a variety of institutions in America. The system in itself does not offer instructional guidelines to teachers, although new users do have access to a library of previous written 'lessons'. The system has considerable facilities including a communication network between authors, graphical and animated representations, votrax, ease of programming, etc. The emphasis tends to be on the use of the system rather than strict instructional evaluation.

SMITH, S.G. & SHERWOOD, B.A. (1976) The Educational Uses of the PLATO. Computer System. Science, 192, 344-352.

CHABBAY, R. & SMITH, S.G. (1977) The Use of Computer Based Chemistry Lessons. Journal of Chemical Education, 54, 12, 745-747.

SMITH, S.G. & CHABAY, R. (1977) Computer Games in Chemistry. Journal of Chemical Education, 54, 688-689.

HYATT G.W., EADES, D.C. & TENCZAR, P. (1972) Computer Based Education in Biology. Bio. Science. July.

American J. of Correction, 1978, Jan-Feb.

4.9 Coordinated Science Laboratory - University of Illinois

General: Projects concerned with computer based training for fault diagnosis tasks. Some work has used troubleshooting of graphically displayed networks and the effect of network size, forced pacing, and computer aiding have been investigated in both learning and transfer situations. This work is described in the following references.

ROUSE, W.B. (1978) Human Problem Solving Performance in a Fault Diagnosis Task. IEE Transactions on Systems, Man and Cybernetics. Vol. SMC-8, No. 4, 258-271.

ROUSE, W.B. (1979) Problem Solving Performance of Maintenance Trainees in a Fault Diagnosis Task. Human Factors, 21, 2, 195-203.

ROUSE, W.B. (1978) A Model of Human Decision Making in a Fault Diagnosis Task. IEEE Transactions on Systems, Man and Cybernetics, Vol. SMC-8, No.5, 357-361.

JOHNSON, W.B., HUNT, R.M. & ROUSE, W.B. (1979) The Use of Computer Simulators for Training Powerplant Mechanics.

4.10 Aviation Institute - University of Illinois

Projects (a) Flight Simulation Training. A Plato IV computer-assisted instruction system was designed to teach pilots to fly holding patterns in various wind conditions. Students used a joystick interface with a simulated flight display which was computerised. Results were favourable for the computer instructed group in terms of learning, transfer and attitude.

TROLLIP, S.R. (1979) An evaluation of a complex computer-based flight procedures trainer. Human Factors

TROLLIP, S.R. (1977) An evaluation of a complex computer-based flight procedures trainer. Tech. Rep. ARL-77-1/AFOSR-77-1.

FINNEGAN, J.P. (1977) Evaluation of the transfer and cost effectiveness of a complex computer-assisted flight procedures trainer. Tech. Rep. ARL-77-7/AFOSR-77-6.

(b) Maintenance Training. A variety of modules in, for example, welding are available for individualised CAL. The computer also exhibits a management function by keeping records and organising the instructional programmes and resources.

(c) Computer Managed Instruction. The Plato system is used to help pilots evaluate their progress towards the certification in general aviation which is a test administered by F.A.A. Students can be tested in various areas of aviation of Plato terminals, in order to determine their areas of weakness.

ALPERT, D. & BITZER, D. (1970) Advances in computer based education. Science, 167, 1582-1590.

TROLLIP, S.R. A Computer-based study guide for Aviation Certification. Internal Memo.

4.11 Psychology Department - University of Illinois

Projects (a) Transfer of Training and Simulation Design. Basic theoretical and experimental work in aviation psychology.

ROSCOE, S. (1971) Incremental Transfer Effectiveness. Human Factors, 13, 6, 561-567.

POVENMIRE, H.K. & ROSCOE, S.N. (1971) An evaluation of ground-based flight trainers in routine primary flight training.

ROSCOE, S.N. (1974) Man as a previous resource: the enhancement of human effectiveness in flight operations. AIAA Life Sciences and Systems Conference, Texas.

POVENMIRE, H.K. & ROSCOE, S.N. (1973) Incremental transfer effectivenss of a ground-based general aviation trainer. Human Factors, 15, 6, 534-542.

HOPKINS, C.O. (1975) How much should you pay for that box. Human Factors, 17, 6, 533-541.

SIMONELLI, N.M. & ROSCOE, S.N. (1979) Apparent size and visual accommodation under day and night conditions. Tech. Rep. Eng. Psy. 79-3/ AFOSR-79-3.

4.12 Naval Personnel Research and Development Centre

Projects (a) Tactical Skills. This involves the application of AI to the training of tactical decisions on a ship via a CRT. Another related project examined problems of recognition of ships using semantic networks, again using a computer based technology (Mike Williams).

(b) Basic skills for selection and training. The problem was to examine the components of reading and literacy skills which needed to be taught given the lower recruitment standards. This extensively used task analysis techniques. Another related project examined the comprehensibility of certain text material using different criteria (Aitken & Duffy).

(c) Electronic warfare training. Use of computer based training for electronic countermeasures (e.g. radar jamming). Such skills could be trained and practiced with a computerised simulation remote from the training centre (B. Ellis).

(d) Instructional design. The Instructional Quality Inventory provided quality control for new and existing instructional materials. It assures the adequacy of learning objectives and the internal consistency of test items in any training programme.

WULFECK, W.H., ELLIS, J.A., RICHARDS, R.E., MERRILL, D. & WOOD, N.D. (1978) The Instructional Quality Inventory: 1. Introduction and Overview. NPRDC SR 79-3.

ELLIS, J.A. & WULFECK, W.H. (1978) The Instructional Quality Inventory IV. Job Performance Ad. NPRDC Special Report. 79-5.

(e) Computer Managed Instruction. A large scale CMI system in the Navy automates performance testing in some preparatory technical courses for Radiomen. Error analyses are generated by which each trainee can evaluate and improve his performance. (1968 began). N. Van. Moder.

General

WOLFE, J.H. & WILLIAMS, M.D. (1979) Prospects for low cost advanced computer-based training: A forecast. NPRDC Special Rep. 79-16.

4.13 Behavioural Technology Laboratories

Project (a) AIDE system is a computer based training system. It provides trainee technicians with assistance, instruction and drill and practice in fault finding with a piece of equipment. This is being developed with a microprocessor and interactive display using a sonic pen. The flexibility with which the trainee can examine various forms of technical information is impressive. As yet this system is not implemented or fully evaluated from an instructional perspective.

TOWNE, D.M. (1979) The Automated Integration of Training and Aiding Information for the Operator/Technician.

Complete Bibliography of Technical Reports.

5. CONCLUSIONS

The purpose of this study visit was to examine the manner in which computer based training (CBT) is being used in a variety of contexts in America. Almost all of the projects described within this report are still in the developmental research stage and consequently few have been evaluated in the classical manner. Consequently the conclusions which one can draw are largely intuitive and should be treated in this light. On the other hand it was not expected that hard generalisations would emerge and the study visit was more realistically aimed at examining the "philosophy" and "ideas" underpinning these various research projects. The following issues emerged as being relevant in the area of computer based training (CBT).

1. Within any computer based training system there are two dimensions which can fruitfully be distinguished. Firstly the learning environment has a set of instructional features. Such features could include all those variables which are known to be important in producing efficient learning, e.g. the presentation of relevant feedback concerning a response, the sequence and pacing of items under learner control, the fidelity of simulation in psychological terms, etc. Secondly any computer based training system utilises certain hardware and media for communication with the learner. For example, visual images may be presented on a VDU; text might be stored and presented in an auditory mode and a flight simulator might provide trainee pilots with various realistic manoevres. Computer based training should obviously attempt to capitalise on the instructional features of a good learning environment. The involvement of a computer per se does not guarantee the increased efficiency of any learning exercise. Consequently we should resist any temptation to advocate the utilization of computer based training on the basis of hardware alone. Computer based training is only one solution to a training problem and other possible situations should be evaluated on their instructional merits. In some projects in which the computer was essentially a page turner or a presenter of factual material it appears that the potential instructional advantages afforded by CBT were not being exploited.

On the other hand it is difficult to argue that CBT should be evaluated on instructional criteria alone. Firstly, there were a number of projects in which the computer performed a management function. This was particularly useful for training programmes involving the administration of tests and exercises to large numbers of trainees.

Secondly there are many situations in which it could be argued that CBT presents a unique training solution due to the complexity of the subject matter. The speed and flexibility associated with a computer can provide for example, interactive graphic displays or simulated flight data which quickly responds to student inputs. Of course, it is impossible to empirically test the efficacy of certain training solutions and so the training expert has to estimate in advance the likely instructional advantages that CBT could afford. This is by no means an easy matter since at the present time a clearcut instructional technology does not exist and justification of CBT on a priori grounds is often difficult. It is to be hoped that guidelines concerning the use of CBT will begin to emerge as a consequence of many of the ongoing projects.

2. There are a number of ways in which situations in which CBT is being used, differ. Firstly and obviously the contexts differ. Applications in this report cover the clinical, educational, military and occupational contexts. Perhaps not surprisingly the concept of cost effectiveness tended to be less prevalent in the educational contexts. On the other hand there were some instances in the military and occupational contexts in which instructional efficiency and cost effectiveness were factors which were not systematically considered. In these situations the objective was usually to <u>implement</u> a CBT system and success was therefore judged by this accomplishment rather than any other factor.

A second striking way in which CBT systems differed was reflected in the different backgrounds and approaches used by research workers. CBT impinges not only upon

a variety of areas within psychology such as cognitive, artificial intelligence and occupational but also on other disciplines such as education and computer science. Researchers may have backgrounds in any, all or indeed none of these areas. To some extent the expertise of the researchers affects the flavour or orientation of the CBT project. Cognitive psychologists are obviously concerned that for example, the dialogue between the tutor and student is sufficiently sophisticated from an cognitive perspective. Occupational psychologists or even training practitioners may be more concerned that CBT is effective and that it can be assimilated within a particular organisational context. On the other hand computer scientists or engineers may focus on various alternative computer configurations. These different emphases are of course all important dimensions to the same problem, all of which need to be considered in setting up any CBT system. Nevertheless it was difficult not to be left with the impression that some projects which dwelt upon some dimensions to the exclusion of others were delimited as a consequence.

3. One point to be made is that one should not consider CBT as a unitary concept. There are a variety of possible configurations in which a computer may impinge upon the training system. The computer may be,for example,used to present a display of a simulated task such as fault diagnosis or an aircraft landing, it may provide tutorial exercises, or it might manage or administer a training programme. Any element of the training system may be computerised and clearly the problem is to decide in which training functions computer involvement may increase the overall efficiency of the training system.

From the number of projects concerned with the training of problem diagnosis, there appears to be a consensus that the application of CBT is worthwhile in this area. Typically the predominant element of fault diagnosis in many contexts is the ability to interpret symptoms and interrogate a system in a manner which identifies quickly and unambiguously the faulty component. Consequently the decision making of such tasks can be faithfully reproduced by a simulated display and perhaps even more important, trainees strategies of interrogation

can be evaluated against ideal ones and feedback concerning discrepancies should be able to facilitate learning of such complex skills.

Another obvious application for CBT is within large scale organisations, such as the military, which are becoming greater users of computers for non-training functions. In these situations the instructional software can piggyback on the existing system and therefore provide training or refresher courses in a decentralised manner. This type of usage clearly makes considerable savings in terms of trainees travelling time and accommodation expenses not to mention the quicker availability of training packages to a wider audience.

A great number of the projects reviewed involve some novel aspect concerning CBT. However I would like to conclude this report by mentioning two projects which were particularly intriguing. Firstly, Dr. Breaux at NTEC has developed an impressive simulation task for training air traffic controllers. The trainee controller monitors a simulated flight path and the system generates the pilot's speech and analyses the ensuing dialogue. Secondly Dr. Seidel and others at HUMRRO have implemented CBT for a post office sorting task. Not only are occupational applications of this nature rare but the simulation of the sorting task by a variety of computer generated envelopes is interesting and novel.

In the future microtechnology may hold the key to the greater implementation and exploitation of CBT systems. This had been explicitly recognised by many researchers some of whom were already exploring micro-based systems (e.g. PLATO at Illinois and AIDE at Behavioural Technology Laboratories). On the other hand whilst this might provide the extra opportunity which CBT needs, any training system has to be evaluated to a large extent on its instructional merits and in order to design and implement such instructionally efficient systems we must not underestimate the variety of types of expertise which are necessary.